Qualifying Synthetic Fuels for Military Applications

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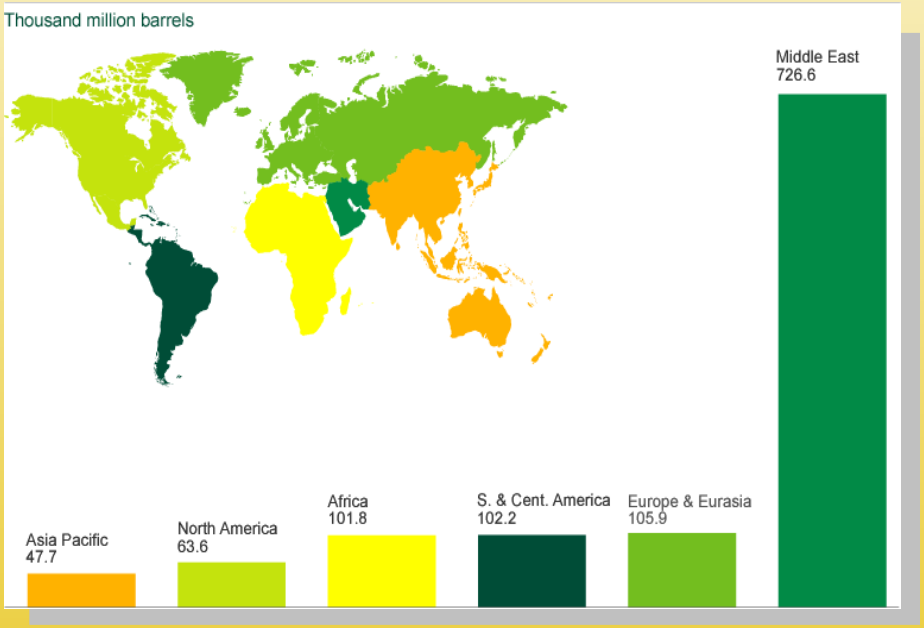
- Dr. Theodore K. Barna - Assistant Deputy Under Secretary of Defense

Crude Oil: Finite Supply, Rising Demand

Proven Oil Reserves at End of



Top World Oil Consumers in 2003

	Country	Total Demand (M BPD)
1)	United States	20.0
2)	China	5.6
3)	Japan	5.4
4)	Germany	2.6
5)	Russia	2.6
6)	India	2.2
7)	South Korea	2.2
8)	Canada	2.2
9)	Brazil	2.1
10)	France	2.1
11)	Mexico	2.0

Source: BP Statistical Review of World Energy 2004 © BP

World Oil Balance, 1Q04

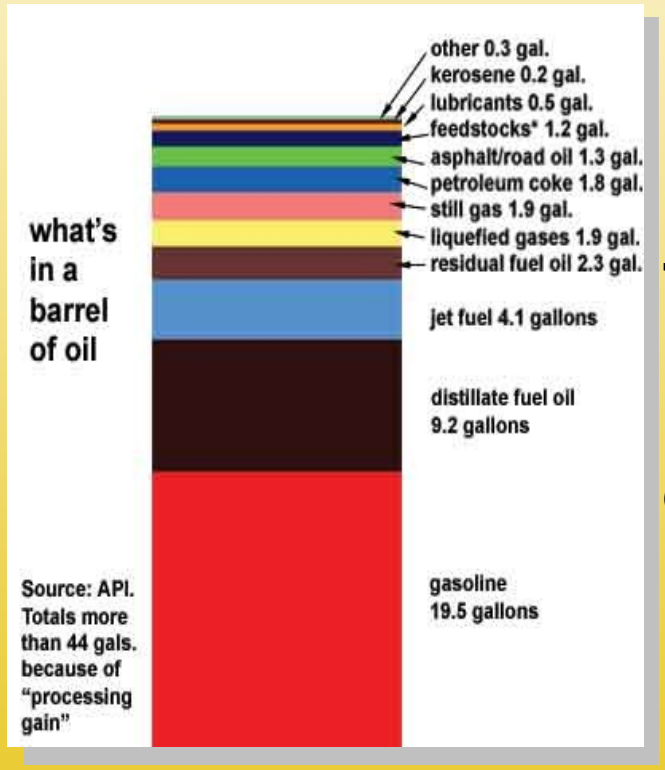
Supply = 82.1M BPD

Demand = 82.3M BPD

International Energy Agency Oil Market Report

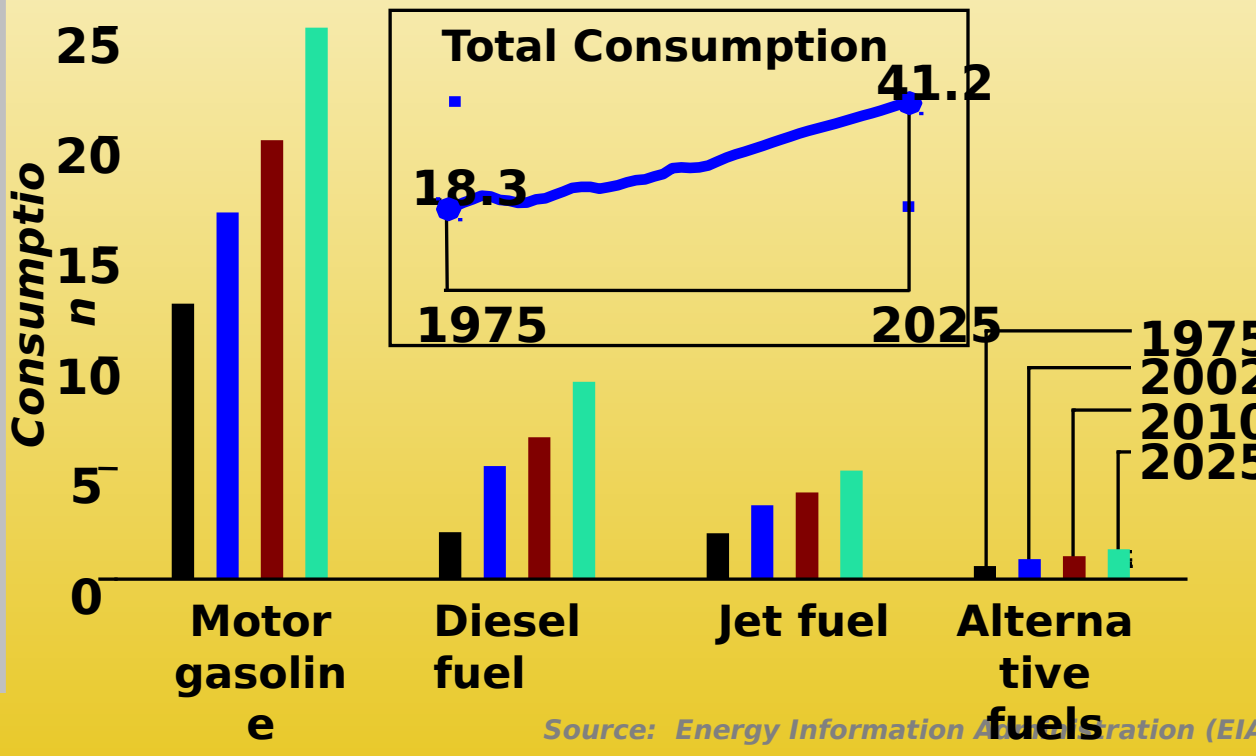
U.S. Demand for Petroleum Products

Many products made from petroleum



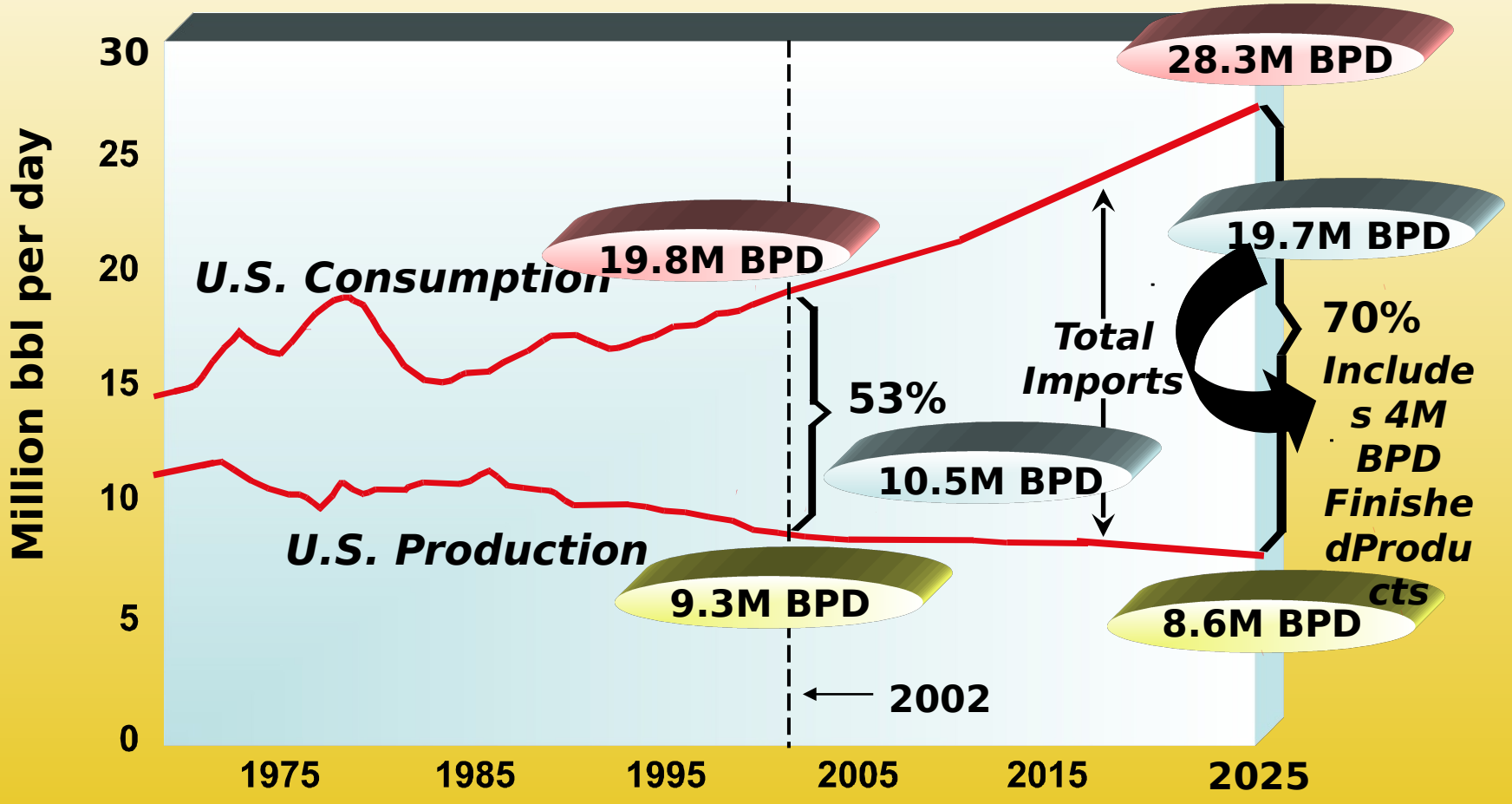
Rising Demand for Transportation Fuels

(Quadrillion Btu/yr)



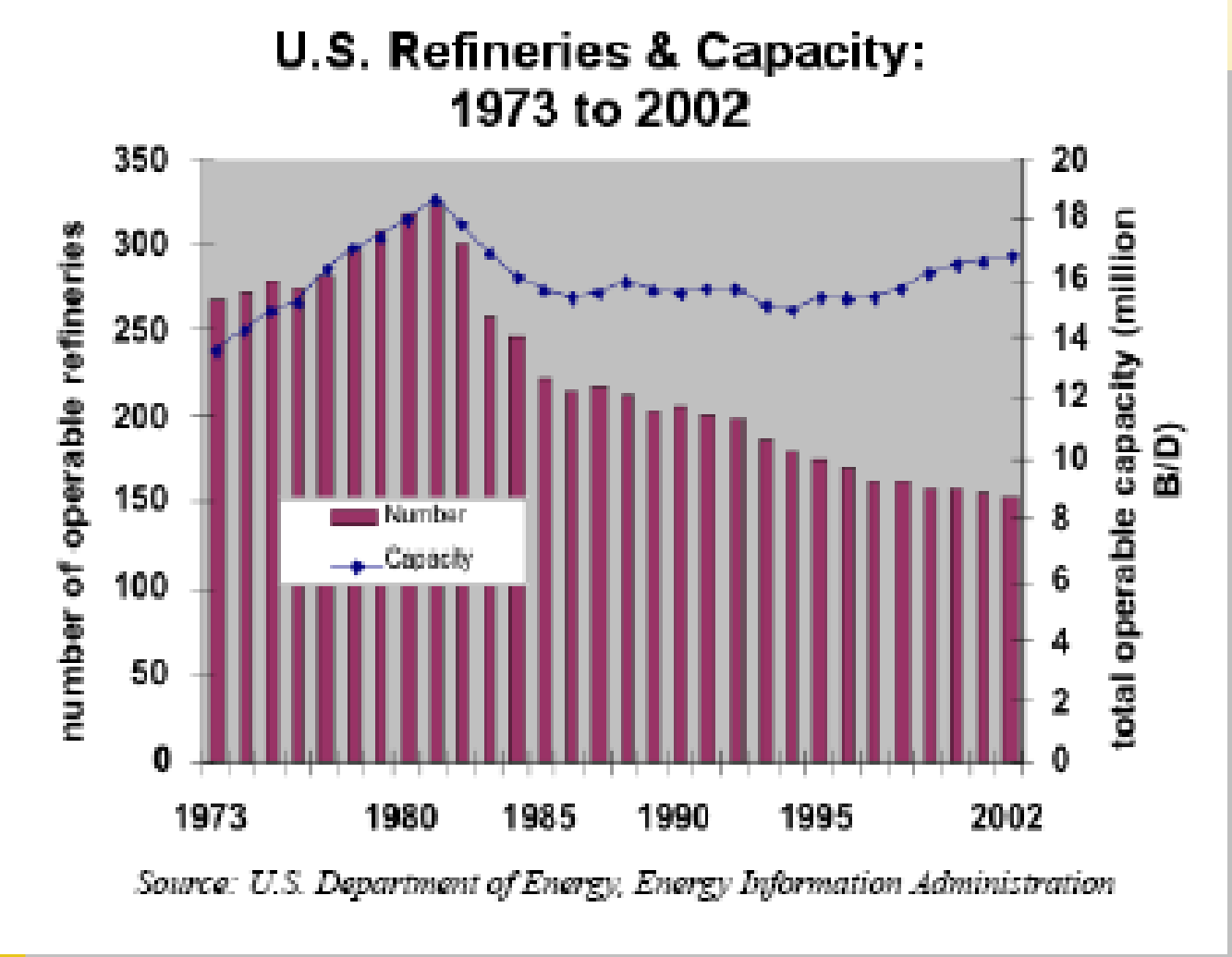
1 Quadrillion Btu = 172M bbl oil

Increasing Reliance on Petroleum Imports



Source: EIA (AEO 2004); Reference Case Scenario [Courtesy John Winslow-DoE]

U.S. Refining Capability Is Strained

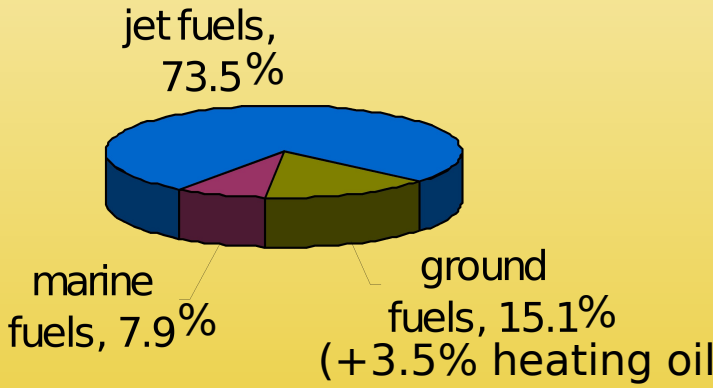


Current Military Transportation Needs – Petroleum

Service	Percent	BPD	BPY
Army	6%	18,500	6.7 M
Air Force	55%	166,000	60.8 M
Navy	38%	114,000	41.8 M
Marines	1%	1,500	0.7 M
Total	***100%***	***300,000***	***110.0 M***

Source: DESC, FY02

Bulk Transportation Fuels



Source: DESC Contract Awards, FY03

Note: 75% Domestic, 25% Overseas

U.S. Hydrocarbon Resources

Natural Gas
184.8 Tcf =
33.3 Million BOE

Coal
250 B tons =
1,138 Billion BOE

Oil Shale
270 B tons =
130 Billion BOE

Equivalent to
1.3 Trillion
Barrels of Oil

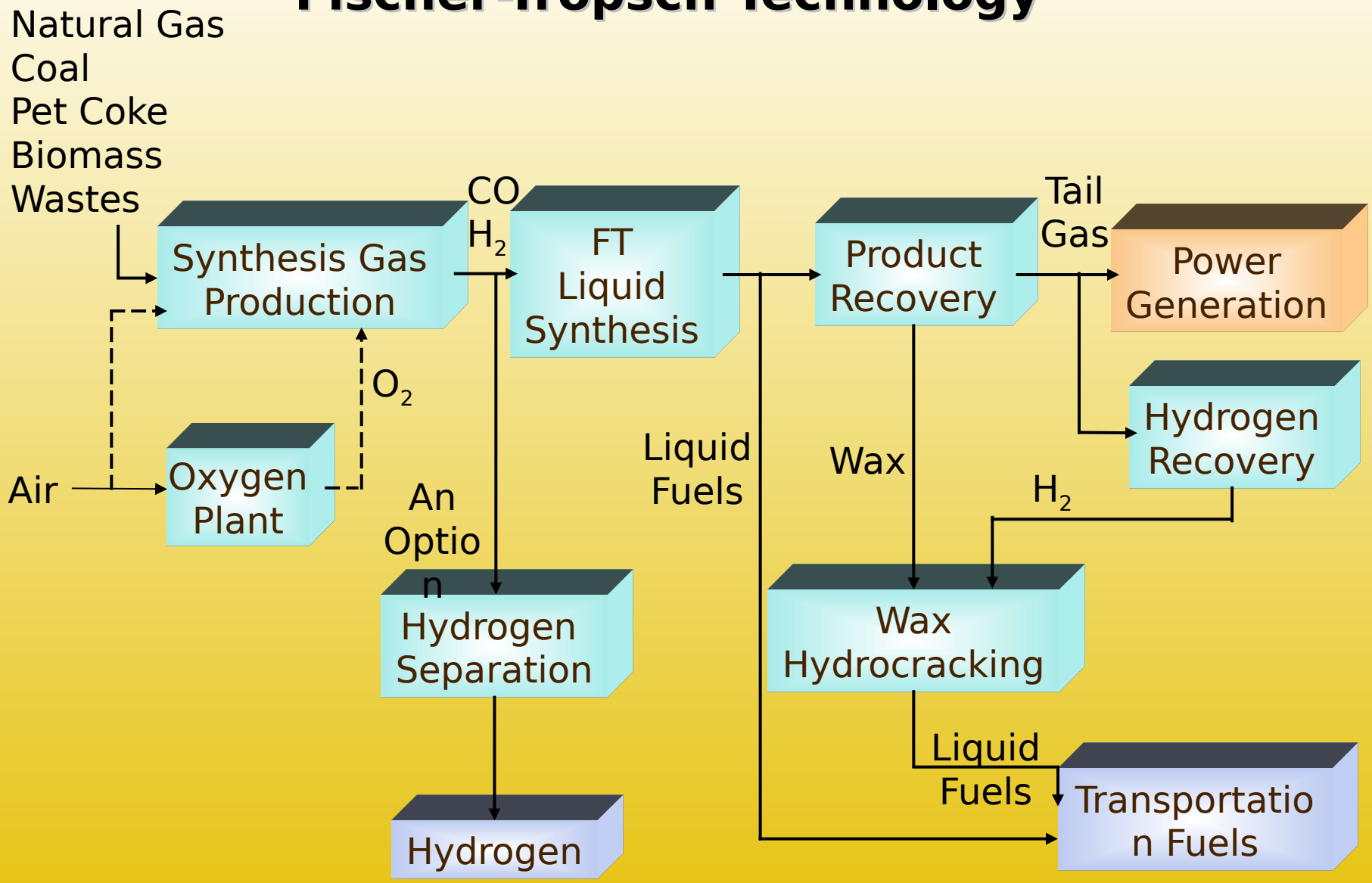
Petroleum Coke
798K BOE/day produced
- 361K BOE/day exported
437K BOE/day available

Tar Sands
6.1 Billion BOE

Biomass
1.2 B tons =
31.75 Billion BOE

BOE = Barrels of Oil Equivalent

Fischer-Tropsch Technology



Emerging Global FT Industry

History of Commercially Operated FT Plants

Company	Years Operated	Capacity (BPD)	Feed Stock
Sasol (S. Africa)	44	160,000	coal
MossGas (S. Africa)	10	22,500	nat. gas
Shell (Malaysia)	7	15,000	nat. gas

FT Projects in U.S.

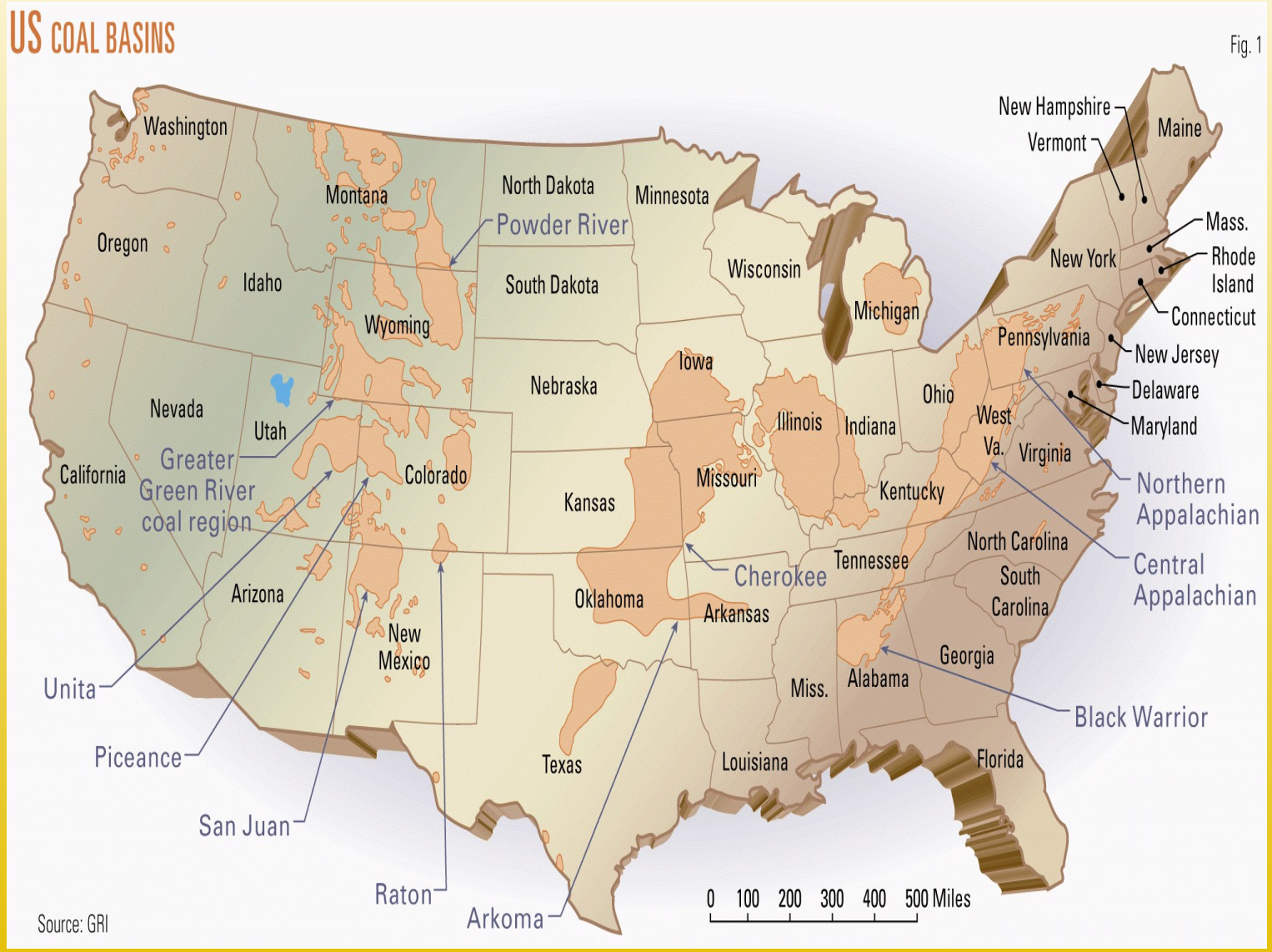
existing

- **BP (Nikiski, AK)**
  - 300 bpd demo plant (2003)
  - FT product to near-by refinery
- **ConocoPhillips (Ponca City, OK)**
  - 400 bpd demo plant
  - Just starting up
- **Syntroleum (Tulsa, OK)**
  - 70 bpd demo plant (late 2003)
  - DoE co-sponsor
- **Rentech (East Dubuque, IL)**
  - Convert nat. gas-fed fertilizer plant to use coal
  - Co-produce FT fuels, fertilizer, and electricity

proposed

- **WMPI (Gilberton, PA)**
  - Convert waste coal to 5000 bpd FT fuels and 41 MWe power
  - DoE co-sponsor

FT Plants
U.S. Energy Security



Benefits to Domestic Production of Non-petroleum Fuels

- Provides Secure Supply
  - U.S. Military & Homeland Security
  - Transportation Market
  - Co-production of Electricity and Fuels
- Promotes Diversity of U.S. Energy Supply
  - Uses most plentiful domestic resources
  - Increases number of suppliers worldwide
  - Encourages monetization of worldwide non-petroleum resources
- Provides Stimulus for U. S. Economic Growth
  - New industry = new jobs
  - Offsets crude oil trade deficit ($200 billion/year)
  - Downward pressure on global energy pricing

Fischer-Tropsch (FT) Fuels
Fuels for the 21st Century

- Can use existing distribution infrastructure
- Cleaner Air – Healthier Lives
  - Exceed EPA 2006 regulations for ultra-low sulfur fuels
    - No sulfur
  - Cleaner burning
    - No aromatics, no sulfur
    - Lower engine exhaust emissions
- Less toxic
  - No aromatics, no heteroatoms
  - Biodegradeable

FT Fuels Being Evaluated

- FT diesel fuel evaluations in bus fleet demonstrations
  - Denali National Park
  - Washington DC WMATA
- Fuels produced at Syntroleum Tulsa Port of Catoosa Demonstration Plant
  - DoE is co-sponsor
    - Ultra-clean Transportation Fuels Program
    - National Energy Technology Laboratory (NETL)
  - Marathon is co-sponsor
  - ICRC Program Manager

DoD-DoE Joint Agency Program for FT Fuels

- FY03 program start
  - Continuing FY04, FY05
- FT jet fuel supplied by Syntroleum Corp. from Tulsa demonstration plant
- Define FT fuel formulations needed to allow use in all DoD equipment
- Coordination of military/commercial aviation communities through Coordinating Research Council (CRC)

Managed by:

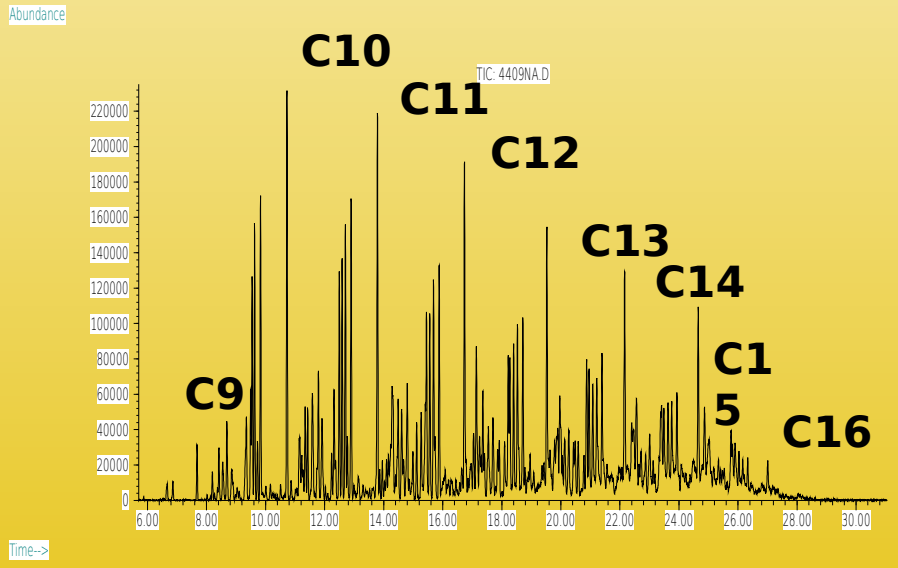
UNITED STATES ARMY
NAC
NATIONAL AUTOMOTIVE CENTER

Research Participants

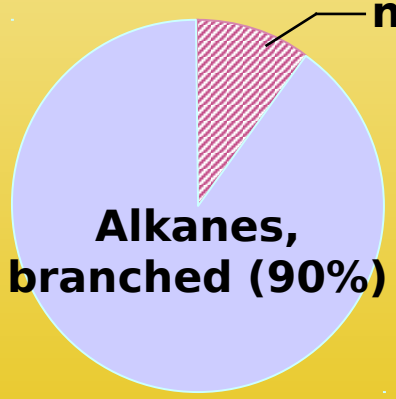
- Air Force
  - Air Force Fuels Research Laboratory/NAFRC
  - University of Dayton Research Institute
- Army
  - TARDEC Fuels & Lubricants Laboratory
  - Southwest Research Institute
- Navy
  - NAVAIR Fuels and Lubricants Laboratory
  - Naval Fuels and Lubricants Integrated Product Team
- DoE
  - National Energy Technology Laboratory
- Syntroleum Corp.

FT Fuels Reduce Emissions

- Less Pollutant Emissions
  - 2.4% less CO_2
  - 50% to 90% less particulate matter (PM)
  - 100% reduction in SOx
  - ~1% less fuel burn (increased gravimetric energy density)



Hydrocarbon types in Syntroleum S-5



Zero aromatics

Zero sulfur

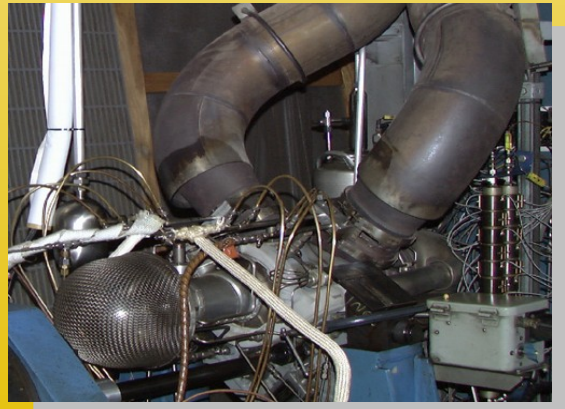
No heteroatoms

Highly Paraffinic Fuel – normal and isoparaffins

Petroleum derived fuels are rich in aromatics, cycloparaffins, and heteroatoms

Reduced Particulate Emissions with FT Fuel Relative to JP-8

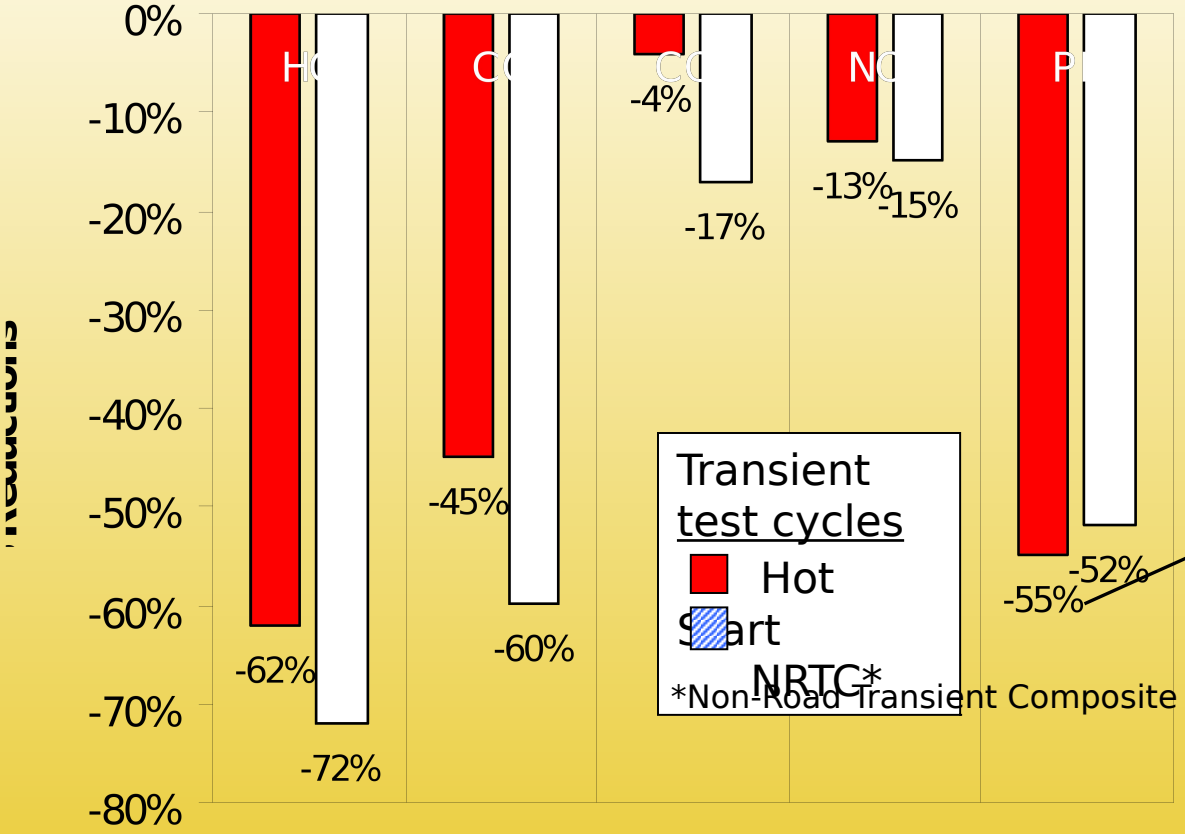
96% reduction* in particulate emissions at idle conditions.



Even moderate fractions of FT fuel blended in JP-8 significantly reduce exhaust emission particulates in T63 turbine engine testing.

** Note: Results are highly dependent on engine model/year and composition of baseline fuel.*

Reduced Exhaust Emissions with FT Fuel Relative to Low-Sulfur Diesel Fuel



Over 50% reduction in particulate emissions in transient mode.

FT fuel burns more completely and emissions are signifcantly cleaner than EPA certified low-sulfur diesel fuel tested in 6.5L diesel engine.

FT Fuels Improve Aerospace Propulsion and Power Systems

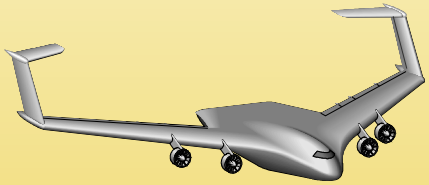
FT iso-paraffinic kerosene (100%)

low emissions, high stability

2.2X – 9X increase in cooling

Current and advanced gas turbine aircraft

(Jet A/JP-8 replacement)



high stability, endotherm

1200 Btu/lb cooling

Hypersonic Vehicles

(JP-7 replacement)

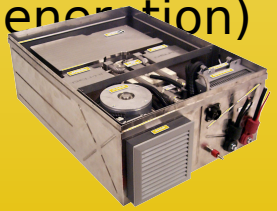
No sulfur, no aromatics

No poisoning, less coking

of reformer catalyst

Hydrocarbon reformers

(fuel cell power generation)



High thermal stability, high H/C

ISP=362.5

Hydrocarbon Rockets

(RP-1 replacement)

FT Fuels Benefit Air/Ground/Marine Propulsion and Power Systems

FT Fuels

clean alternative to petroleum fuel
(MADE IN USA)

E.O. 13149, EPAct

Alternative Fuel Vehicles (AFVs)
(non-tactical fleets; Post, Camp &

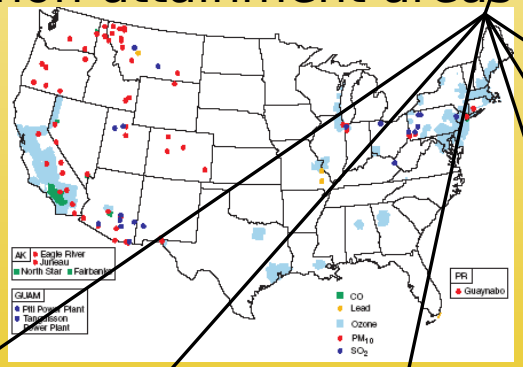
reduced exhaust pollutants
lower CO, PM, NOx

easier starts, all climates
high cetane, >74

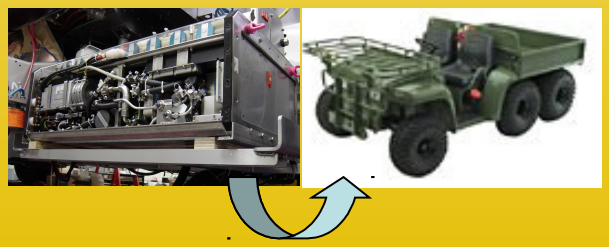
source of hydrogen
easily reformed

Diesel engine fleets

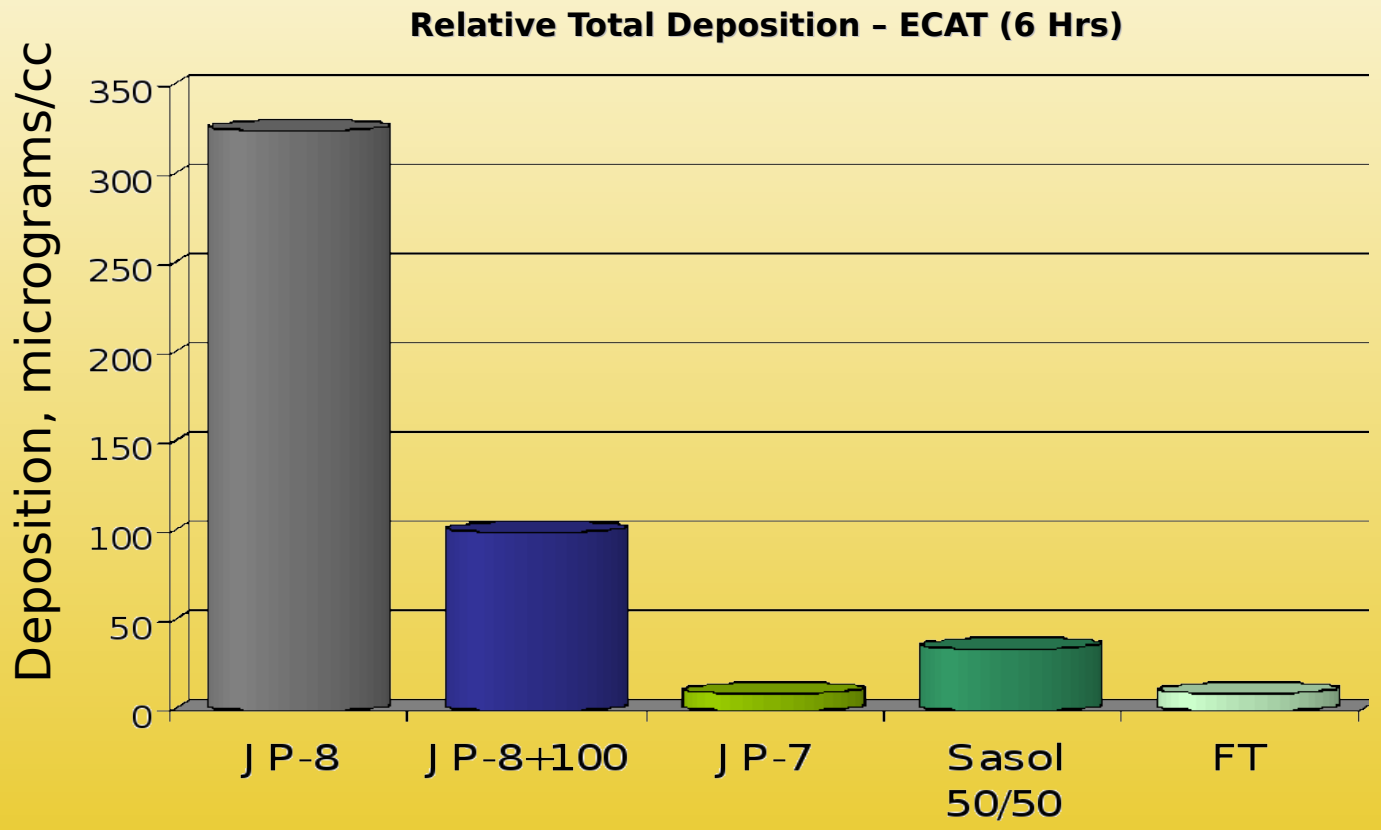
Fleets operating in non-attainment areas



Fuel Cell Applications
(APUs in Vehicles)



FT Fuels Have Superior Thermal Stability



Increased fuel thermal stability enables development of very fuel efficient propulsion systems

FT Fuels Have Excellent Low Temperature Properties

S-8

S-5

JP-8

JP-7

Superior Low Temperature Properties Improve High Altitude Operations and Low Temperature Starting

FT Fuel Benefits for Navy Shipboard Use

Storage Stability Test Results
(Syntroleum S-5)

Compatibility Evaluation Test Results
(2 FT fuels: F-T 1 and F-T 2)

typical navy fuel

FT fuels

FT fuel responds well to standard antioxidant (AO) used for petroleum

Low copper uptake of FT fuel = good long-term storage stabi

- ***Excellent long-term storage stability***
- ***Significant reduction in copper up-take***
- ***Increased thermal stability / Extended engine life***

FT Fuels –
The Next Single Fuel for the Battlefield

- **Clean Fuels**
  - **Reduced emissions**
  - **No aromatics**
- **Enables Fuel Efficient Designs**
  - **Increased thermal stability**
- **Excellent low-temperature properties allow for:**
  - **higher altitude operations**
  - **improves diesel engine cold-starting capability**

Take Action—
Make It Happen

FT Plants in the U.S. converting our vast hydrocarbon resources into transportation fuels:

- Enhances our energy security
- Promotes diversity of supply
- Stimulates U.S. economic growth
- Leads to Cleaner Air – Healthier Lives

The U.S. Military is preparing to use FT fuels:

- FT fuels offer advantages to the military
- DoD-DoE Joint Program is working to make possible –

FT Fuel for the Military

National Energy Security Post 9/11, June 2002

(a study conducted by the United States Energy Association)

"More than 50% of the gasoline, aviation fuel, heating oil, diesel fuel and other petroleum products come from a dozen or more nations abroad. Some are friendly, some are not. The answer to increased energy security is diversifying our sources of supply . . ."